

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
3 July 2003 (03.07.2003)

PCT

(10) International Publication Number
WO 2003/054954 A3

(51) International Patent Classification⁷: **H01L 21/60**,
G02B 6/42, 6/43

(21) International Application Number:
PCT/US2002/038027

(22) International Filing Date:
26 November 2002 (26.11.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/020,911 19 December 2001 (19.12.2001) US

(71) Applicant: INTEL CORPORATION [US/US]; 2200
Mission College Boulevard, Santa Clara, CA 95052 (US).

(72) Inventors: VANDENTOP, Gilroy; 7742 South Grand-
view Avenue, Tempe, AZ 85284 (US). ZHENG, Jun-Fei;
662 Loma Verde Avenue, Palo Alto, CA 94306 (US).

(74) Agent: HAILS, Robert, L., Jr.; Kenyon & Kenyon, Suite
600, 333 West San Carlos Street, San Jose, CA 95110 (US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU,
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,

CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,
MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE,
SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ,
VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM,
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK,
TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

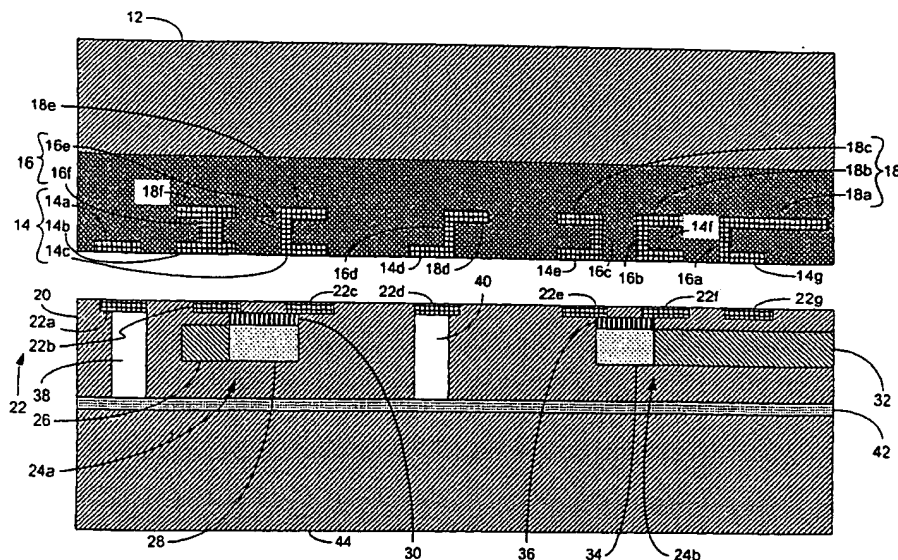
Published:

- with international search report
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments

(88) Date of publication of the international search report:
8 April 2004

For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

(54) Title: ELECTRICAL/OPTICAL INTEGRATION SCHEME USING DIRECT COPPER BONDING



(57) Abstract: An electro-optic semiconductor package and fabrication method provides enhanced performance. An integrated circuit (IC) having one or more IC contact pads is provided, where the IC contact pads are connected to an IC on the IC wafer. An intermediate wafer having one or more intermediate contact pads is provided, where the intermediate contact pads are connected to an electro-optic arrangement on the intermediate wafer. The method further provides for direct copper bonding the IC contact pads to adjacent intermediate contact pads such that an electro-optic semiconductor package results.

INTERNATIONAL SEARCH REPORT

PCT/US 02/38027

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01L21/60 G02B6/42 G02B6/43

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G02B H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 243 509 B1 (CHEN RAY T) 5 June 2001 (2001-06-05)	17-19
Y	claims 3,4; figure 1	1-16, 20-30
Y	WO 01 61743 A (RES TRIANGLE INST) 23 August 2001 (2001-08-23) the whole document	1-16, 20-30
Y	EP 0 352 020 A (AMERICAN TELEPHONE & TELEGRAPH) 24 January 1990 (1990-01-24) the whole document	1-16, 20-30
Y	EP 0 801 423 A (HUGHES AIRCRAFT CO) 15 October 1997 (1997-10-15) the whole document	9-11, 20-25, 29,30
	-/--	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "Z" document member of the same patent family

Date of the actual completion of the international search

26 January 2004

Date of mailing of the international search report

10. 02 2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Kästner, M

INTERNATIONAL SEARCH REPORT

PCT/US 02/38027

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 426 849 A (HASEGAWA SHINICHI ET AL) 27 June 1995 (1995-06-27) the whole document ----	9-11, 20-25, 29,30
A	US 6 204 164 B1 (ORCHARD-WEBB JONATHAN H) 20 March 2001 (2001-03-20) the whole document ----	
A	WO 92 11113 A (GEN ELECTRIC) 9 July 1992 (1992-07-09) the whole document ----	
A	US 3 744 120 A (BURGESS J ET AL) 10 July 1973 (1973-07-10) the whole document ----	
A	US 6 107 118 A (AZDASHT GHASSEM ET AL) 22 August 2000 (2000-08-22) the whole document ----	
Y	EP 1 041 418 A (TOPPAN PRINTING CO LTD) 4 October 2000 (2000-10-04) the whole document ----	1-3, 14-16, 26,29,30
P,X	US 2002/076130 A1 (PANDRAUD GREGORY) 20 June 2002 (2002-06-20) the whole document -----	5,17

INTERNATIONAL SEARCH REPORT

PCT/US 02/38027

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-4,14-16,26,29,30

electrically bonding a chip to an an interposer by direct copper bonding

2. Claims: 5-13, 17-25, 27, 28

full integration of an optical arrangement including waveguide, coupler and electro-optic converter into an interposer

INTERNATIONAL SEARCH REPORT

PCT/US 02/38027

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6243509	B1	05-06-2001	AU 7885900 A	26-03-2001
			WO 0116630 A1	08-03-2001
WO 0161743	A	23-08-2001	AU 4144701 A	27-08-2001
			CA 2399282 A1	23-08-2001
			EP 1275142 A1	15-01-2003
			JP 2003523627 T	05-08-2003
			WO 0161743 A1	23-08-2001
			US 2003211705 A1	13-11-2003
EP 0352020	A	24-01-1990	US 4937653 A	26-06-1990
			DE 68918775 D1	17-11-1994
			DE 68918775 T2	16-02-1995
			EP 0352020 A2	24-01-1990
			JP 1853074 C	21-06-1994
			JP 2067742 A	07-03-1990
			JP 5074224 B	18-10-1993
			US RE35119 E	12-12-1995
EP 0801423	A	15-10-1997	EP 0801423 A2	15-10-1997
			JP 2918863 B2	12-07-1999
			JP 10075055 A	17-03-1998
US 5426849	A	27-06-1995	JP 2616588 B2	04-06-1997
			JP 4312998 A	04-11-1992
			JP 4312999 A	04-11-1992
			JP 2751678 B2	18-05-1998
			JP 5037159 A	12-02-1993
			JP 2776096 B2	16-07-1998
			JP 5206643 A	13-08-1993
			JP 3016292 B2	06-03-2000
			JP 5144973 A	11-06-1993
			JP 2921223 B2	19-07-1999
			JP 5144974 A	11-06-1993
			CA 2059020 A1	10-07-1992
			DE 69223657 D1	05-02-1998
			DE 69223657 T2	30-04-1998
			EP 0494668 A2	15-07-1992
			US 5321210 A	14-06-1994
			CA 2074648 A1	27-01-1993
			DE 69218319 D1	24-04-1997
			DE 69218319 T2	10-07-1997
			EP 0526133 A2	03-02-1993
			US 5628852 A	13-05-1997
			US 5686702 A	11-11-1997
			CA 2083077 A1	19-05-1993
			DE 69213890 D1	24-10-1996
			DE 69213890 T2	30-01-1997
			EP 0543331 A2	26-05-1993
			CA 2083072 A1	22-05-1993
			DE 69220892 D1	21-08-1997
			DE 69220892 T2	20-11-1997
			EP 0543364 A2	26-05-1993
			US 5322593 A	21-06-1994
US 6204164	B1	20-03-2001	CA 2156941 A1	22-02-1997
			WO 9707538 A1	27-02-1997
			EP 0846338 A1	10-06-1998

INTERNATIONAL SEARCH REPORT

PCT/US 02/38027

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9211113	A	09-07-1992	US 5418002 A	23-05-1995
			CA 2076549 A1	25-06-1992
			DE 69122958 D1	05-12-1996
			DE 69122958 T2	28-05-1997
			EP 0516819 A1	09-12-1992
			JP 5504933 T	29-07-1993
			JP 3111077 B2	20-11-2000
			WO 9211113 A1	09-07-1992
US 3744120	A	10-07-1973	US 3854892 A	17-12-1974
US 6107118	A	22-08-2000	DE 19529490 A1	13-02-1997
			WO 9706557 A1	20-02-1997
EP 1041418	A	04-10-2000	CA 2302899 A1	30-09-2000
			EP 1041418 A2	04-10-2000
			JP 2000347051 A	15-12-2000
			TW 460717 B	21-10-2001
			US 6438281 B1	20-08-2002
			JP 2000347052 A	15-12-2000
US 2002076130	A1	20-06-2002	GB 2370409 A	26-06-2002
			AU 2220502 A	24-06-2002
			WO 0248765 A1	20-06-2002